

GeneLab: Scientific partnerships and an open-access database to maximize usage of omics data from space biology experiments

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Abstract

NASA's mission includes expanding our understanding of biological systems to improve life on Earth and to enable long-duration human exploration of space. The GeneLab Data System (GLDS) is NASA's open-access omics data platform for biological experiments. GLDS houses high-throughput sequencing and other omics data from spaceflight-relevant experiments using community-developed data standards. The GeneLab project at NASA-Ames Research Center is developing the database, and also partnering with spaceflight projects through sharing or augmentation of experiment samples to expand omics analyses on precious spaceflight samples. The partnerships ensure that the maximum amount of data is garnered from spaceflight experiments and made publically available as rapidly as possible via the GLDS.

GLDS Version 1.0, went online in April 2015. New capabilities and data releases occur every 6-8 weeks. As of October 2016, the GLDS contains 81 datasets and has data search and download capabilities. Version 2.0 is slated for release in September of 2017 and will have, integrated search capabilities across GeneLab and other public omics databases (NCBI GEO, PRIDE, MG-RAST). Future phases will include developing a collaborative platform for omics data analysis.

Data from experiments that explore the biological effects of the spaceflight environment on a wide variety of model organisms are housed in the GLDS including data from rodents, invertebrates, plants and microbes. Human datasets are currently limited to those with anonymized data (e.g., from cultured cell lines). GeneLab ensures prompt release and open access to high-throughput genomics, transcriptomics, proteomics, and metabolomics data from spaceflight and ground-based simulations of microgravity, radiation or other space environment factors. The data are meticulously curated to assure that accurate experimental and sample processing metadata are included with each data set. GLDS download volumes indicate strong interest of the scientific community in these data.

To date GeneLab has partnered with multiple experiments including two plant (*Arabidopsis thaliana*) experiments, two mice experiments, and several microbe experiments. GeneLab optimized protocols in the rodent partnerships for maximum yield of RNA, DNA and protein from tissues harvested and preserved during the SpaceX-4 mission, as well as from tissues from mice that were frozen intact or partially dissected during spaceflight and later dissected on the ground. Analysis of GeneLab data will contribute fundamental knowledge of how the space environment affects biological systems, and as well as yield terrestrial benefits resulting from mitigation strategies to prevent effects observed during exposure to space environments.

GeneLab Mission and Vision

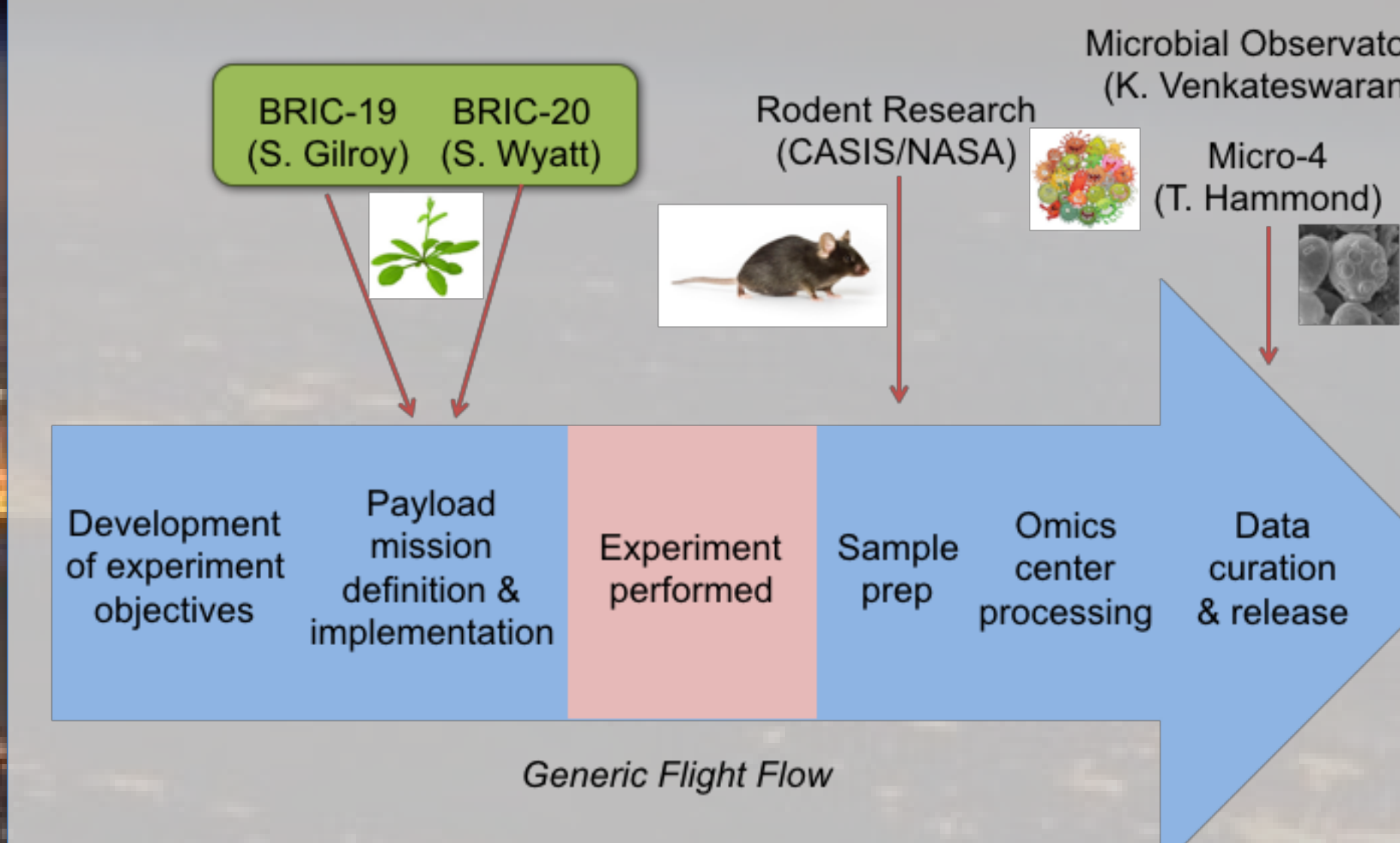
MISSION

Enabling space exploration through data-driven biological discovery

VISION

- Design and deploy a unique repository housing high-throughput molecular data generated from spaceflight and spaceflight-relevant experiments (collectively called "omics" - transcriptomic, proteomic, epigenomic, metagenomic and metabolomics data)
- Partner with spaceflight-relevant projects through sample sharing or augmentation of experiment samples to expand omics analyses on precious spaceflight biological samples
- Make well-curated spaceflight omics data publically available as expediently as possible so that analyses of the data can lead to major advances in countermeasures that will drive human exploration of space as well as benefit life on Earth.

Collaborations



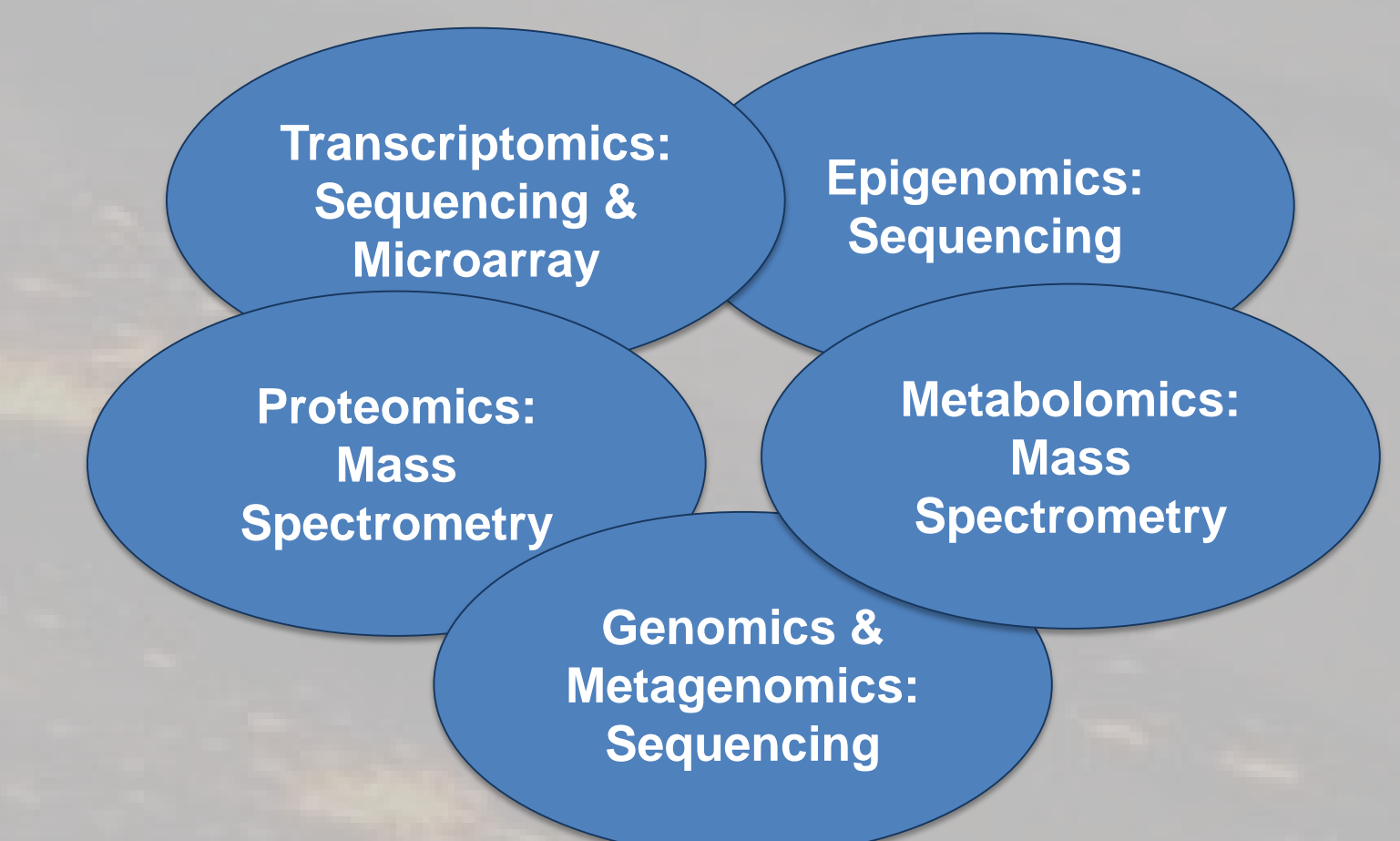
- GeneLab can partner with experiments at any point in the process
- Partners include PIs from academic institutions, NASA-directed projects and commercial experiments
- Experimental samples can be handled in the PI lab, or by GeneLab. GeneLab's Wetlab team is skilled at optimizing sample preparation from a variety of sample/tissue types for multi-omic analysis.

Multi-Omics Science

- What types of organisms?



- What types of data?



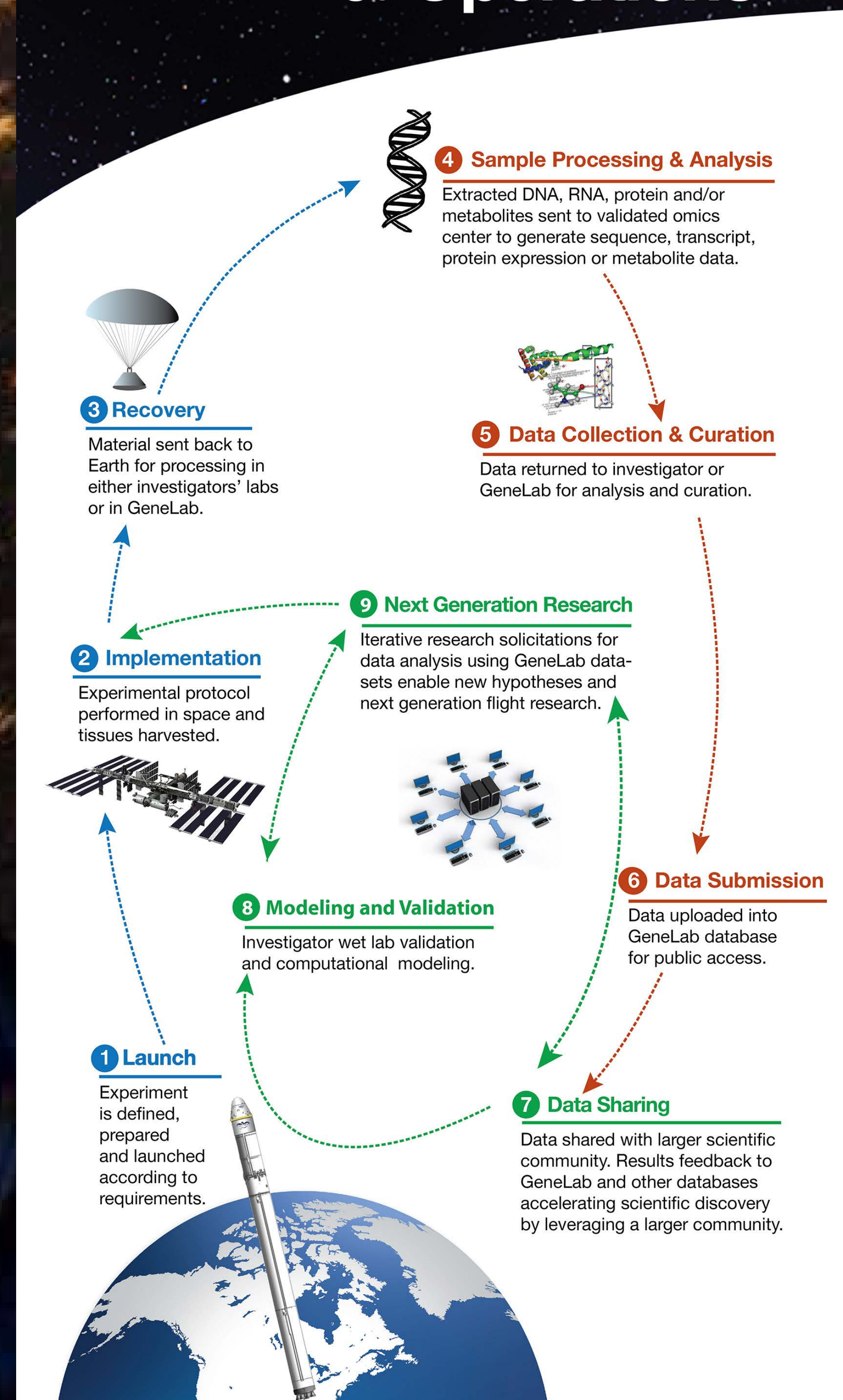
- What types of experiments?

- Spaceflight experiments
- Ground experiments that examine spaceflight phenomena
- Unloading experiments, microgravity simulations: levitation, rotating wall vessel
- Radiation experiments especially using HZE ions that mimic galactic particle events
- Hypergravity - "gravity as a continuum"

- What data are already available?

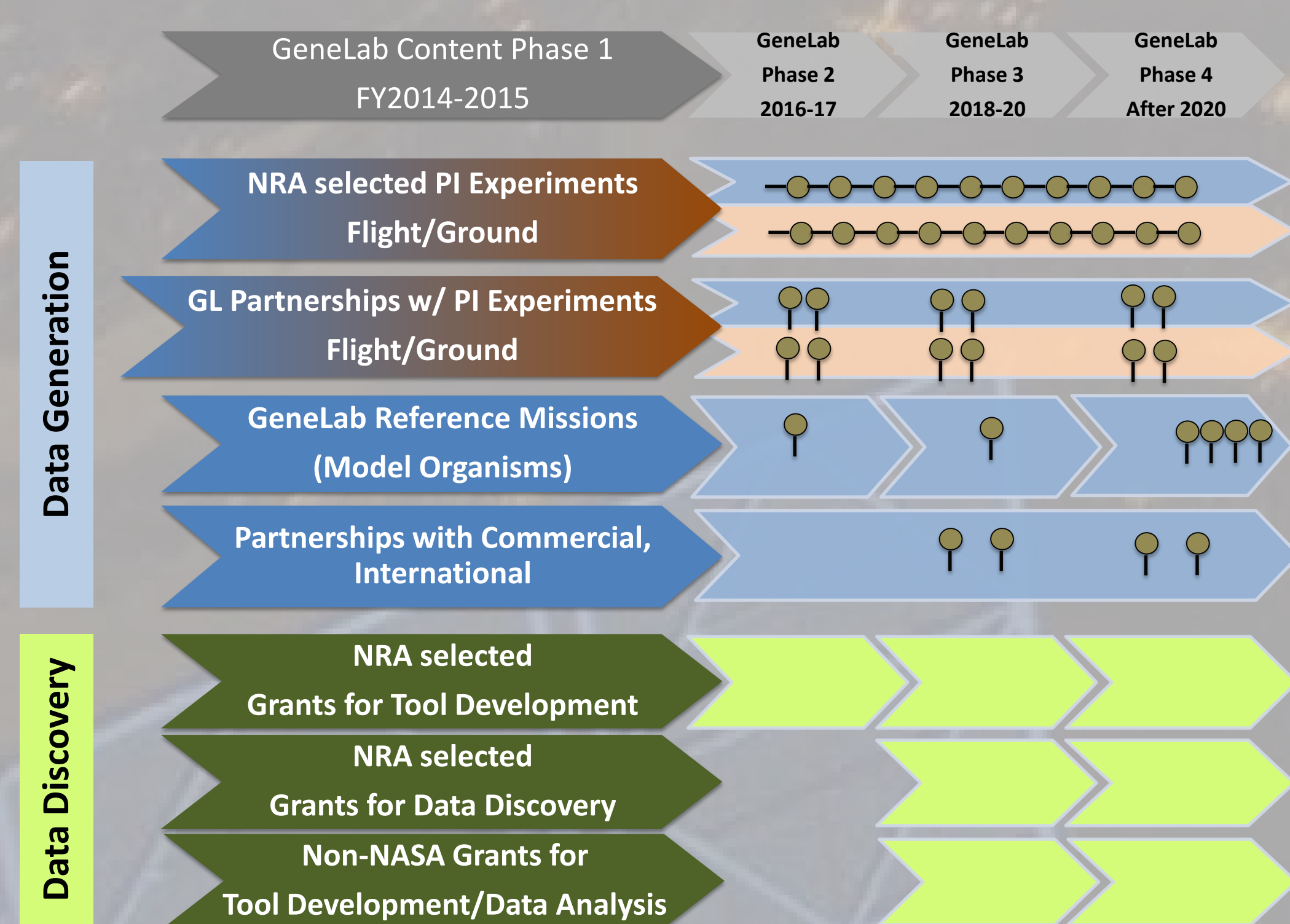
Go To: <https://genelab-data.ndc.nasa.gov/genelab/>

Concept of Operations



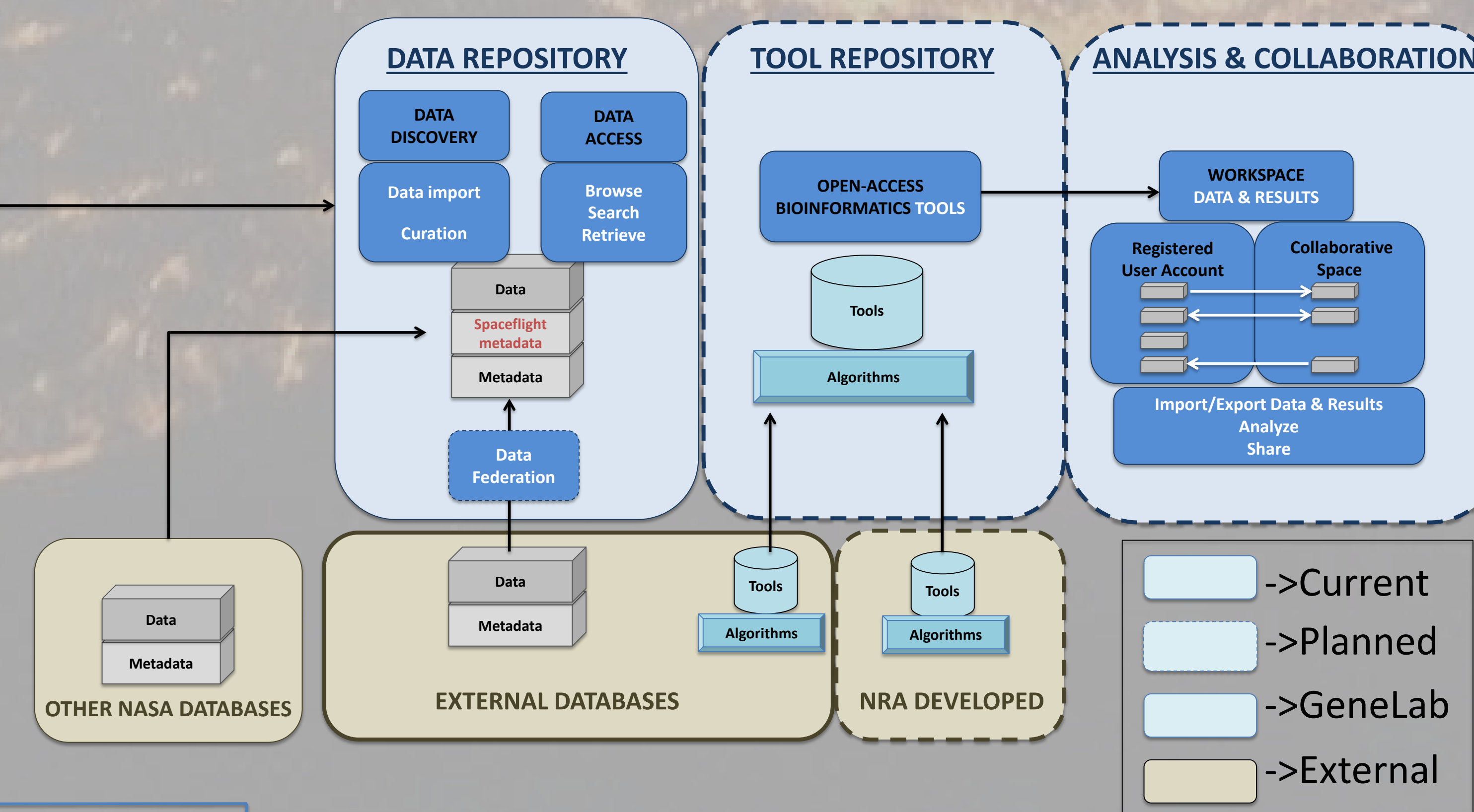
Data Generation

- How is data generated?
- Data discovery opportunities

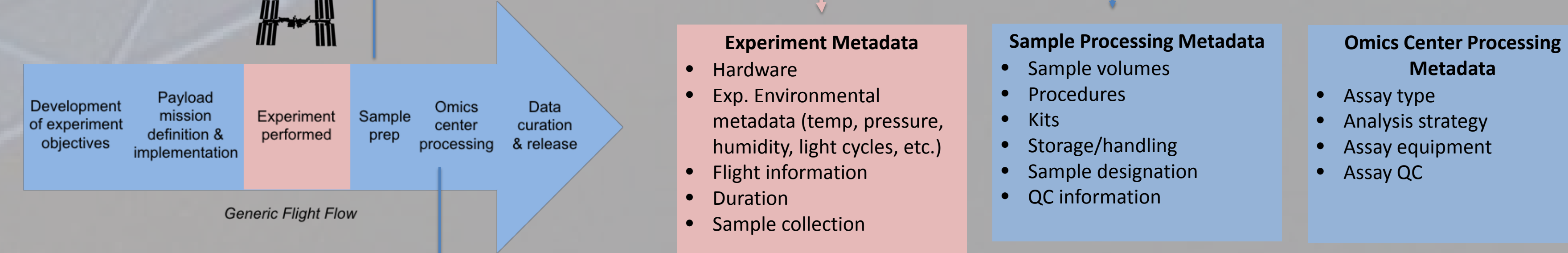


Data System

- What is the structure of the GL Data System?
- What are the planned capabilities?



Metadata Sources



Who is GeneLab?

The GeneLab project team comprises computer scientists, biologists and bioinformaticians at NASA Ames Research Center. Science direction is provided by the Space Life and Physical Sciences Division (SLPSRA) at NASA Headquarters. Project funding is provided jointly by SLPSRA and the International Space Station Research Integration Office at NASA Johnson Space Center.

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<https://genelab.nasa.gov/>